Components of Preparedness

Components of preparedness statements are published by the NMTCB to assist students, program directors, and item writers. Each task is keyed to the 2009 Task Analysis published by the NMTCB, which is the basis for the NMTCB exam. These tasks apply to the equipment, procedures, and pharmaceuticals that are published with the Task Analysis. Within each task, the Components of Preparedness have four subheadings. The first, *Content base*, lists the aspects of cognitive knowledge that apply to the task. The other three subheadings provide learning objectives for the task at three different taxonomic levels. The *Comprehension* level asks for recall of information, such as definitions, regulations, and procedures, without applying them to any specific situation. The *Application* level asks how a task is performed in a prospective manner, and may include calculations and determination of numeric quantities. The *Analysis* level takes a particular situation and asks about interpretation, evaluation and correction of results. While there is only one objective listed under each taxonomic level, keep in mind that each task may have several objectives in each level. The listed objectives are given as examples of questions that can be written at each level.

GROUP I: RADIATION SAFETY (15%)

Task #1: Post appropriate signs in designated areas to comply with NRC regulations

Content base

1. NRC regulations
    a. Restricted & unrestricted areas
    b. Effective dose equivalent limits
2. Radiation surveys
    a. Survey meters
    b. Area monitoring
3. Radiation units
4. Inverse square law and shielding equation

Comprehension

Ex. Identify appropriate signs for posting in designated radiation areas.

Application

Ex. Given a radiation measurement, calculate the area to be designated according to NRC regulations.

Analysis

Ex. Determine appropriateness of posted radiation signs.

Task #2: Prepare and package radioactive materials for transportation

Content base

1. Regulatory requirements
    a. NRC
    b. DOT
2. Radiation surveys of packages
    a. Survey meters
    b. Well counters
    c. Surface contamination limits
    d. Shipping labels
3. Packaging types (materials)
    a. Exempt quantities
    b. Non-exempt quantities
4. Record-keeping

Comprehension

Ex. State the regulatory requirements for packaging and transporting radioactive materials.

Application

Ex. Based on exposure rate and activity, determine the appropriate shipping label for a quantity of radioactive material.

Analysis

Ex. Analyze consequences of improper packaging of radioactive materials and take appropriate actions.

Task #3: Use personal radiation monitoring devices

Content base

1. NRC regulations
    a. Effective dose equivalent limits
    b. Monitoring requirements
2. Types, characteristics, and proper use of personal monitoring devices
3. Properties of radioactivity
4. Radiation surveys
    a. Area monitoring
    b. Patient monitoring
5. Exposure limits
    a. Hospitalized patients
    b. Hospital personnel
    c. General public
6. Record-keeping

Comprehension

Ex. Identify various personal monitoring devices and explain their proper use.

Application

Ex. Determine appropriate personal monitoring devices for given circumstances.

Analysis

Ex. Analyze personal monitoring results and recommend corrective action as needed.

Task #4: Review monthly personnel exposure records

Content base

1. NRC regulations
    a. Effective dose equivalent terms and limits
    b. ALARA concepts
2. Properties of radioactivity
3. Absorbed dose units
4. Types, characteristics, and proper use of personnel monitoring devices
5. Record-keeping

Comprehension

Ex. State the total effective dose equivalent limit for radiation personnel.

Application

Ex. Examine monthly personnel exposure records for compliance with regulations.

Analysis

Ex. Analyze instances of increased radiation exposure and recommend measures to reduce or eliminate unnecessary exposure.

Task #5: Take appropriate measures to reduce radiation exposure

Content base

1. NRC regulations
    a. Effective dose equivalent limits
    b. ALARA concepts
    c. Shielding requirements
2. Properties of nuclear radiation
3. Radiation units
4. Biological effects of radiation
5. Radiation protection techniques
    a. Time
    b. Distance
    c. Shielding

6. Exposure rate calculations
7. Types and characteristics of personnel monitoring devices
8. Radiation surveys
    a. Area monitoring
    b. Patient monitoring
9. Record-keeping

Comprehension

Ex. Identify proper measures to reduce radiation levels and to keep exposure as low as reasonably achievable.

Application

Ex. Calculate changes in exposure rates resulting from use of radiation protection techniques.

Analysis

Ex. Examine instances of increased radiation levels and recommend measures to reduce them.

Task #6: Notify the appropriate authority of excessive radiation exposure

Content base

1. NRC regulations
    a. Acceptable ranges for diagnostic and therapeutic procedures
    b. Effective dose equivalent limits (TEDE, etc.)
    c. Reporting procedures
2. Types and characteristics of personnel and patient monitoring devices
3. Radiation surveys
    a. Survey meters
    b. Area monitoring
4. Exposure rate calculations

Comprehension

Ex. Identify unacceptable levels of radiation exposure and the appropriate authority to notify.

Application

Ex. Determine if excessive radiation exposure has occurred and select the appropriate authority to notify.

Analysis

Ex. Analyze instances of excessive exposure and recommend ways to reduce or eliminate unnecessary exposure.

Task #7: Notify the appropriate authority of Medical Events

Content base

1. Regulatory requirements
    a. NRC

i. Recordable events

1. ii. Medical events (reportable)
2. iii. Reporting procedures
    b. FDA
2. Nuclear medicine diagnostic and therapeutic procedures
    a. Approved radiopharmaceuticals
    b. Routes of administration
    c. Activity ranges
3. Record-keeping

Comprehension

Ex. Identify a Medical Event and the appropriate authority to notify.

Application

Ex. Determine an acceptable dose range based on prescribed dose and NRC regulations.

Analysis

Ex. Analyze instances of Medical Events and recommend measures to prevent further occurrences.

Task #8: Utilize proper methods for the use and storage of radioactive materials

Content base

1. Regulatory requirements
    a. NRC
    b. FDA
3. Characteristics of radioactive materials
    a. Physical properties
    b. Radiation emissions
4. Radiation protection techniques
    a. Beta emitters
    b. Gamma emitters
    c. Radioactive gases
5. Storage requirements of radioactive materials
    a. Temperature
    b. Light
    c. Humidity
    d. Ventilation
    e. Shielding
6. Record-keeping

Comprehension

Ex. Identify proper handling and storage methods for radioactive materials.

Application

Ex. Determine if ventilation conditions are adequate for use of radioactive gases.

Analysis

Ex. Analyze circumstances contributing to special hazards associated with a given radioactive material and alter procedures appropriately.

Task #9: Instruct the patient, family and staff in radiation safety precautions after the administration of therapeutic radiopharmaceuticals

Content base

1. NRC regulations
2. Biological properties of radiopharmaceuticals
    a. Biodistribution
    b. Excretion
3. Radiation safety practices
    a. Sodium I-131
    b. Pure beta emitters
4. Communications skills
    a. Written
    b. Oral
5. Patient and personnel monitoring
6. Record-keeping

Comprehension

Ex. Identify radiation safety precautions which should be conveyed to the patient, family and staff following administration of therapeutic radiopharmaceuticals.

Application

Ex. Determine the distance that others must maintain to limit radiation exposure to regulatory levels.

Analysis

Ex. Analyze circumstances contributing to radiation exposure following the administration of therapeutic radiopharmaceuticals and recommend measures to minimize exposure to family and staff.

Task #10: Provide instruction on proper radiation emergency procedures

Content base

1. NRC regulations
2. Radiation safety procedures
3. Management of radiation emergencies

4. Decontamination procedures
5. Operation of radiation detection devices

Comprehension

Ex. Identify equipment required for dealing with a radiation emergency.

Application

Ex. Choose appropriate instructions to be followed in a radiation emergency situation until radiation personnel arrive.

Analysis

Ex. Analyze circumstances contributing to radiation exposure in a radiation emergency and recommend procedures to minimize exposure.

Task #11: Perform wipe tests and area radiation surveys

Content base

1. NRC regulations
2. Properties of nuclear radiation
3. Radiation units
4. Survey instruments and well-counters
5. Area monitoring
    a. Area surveys
    b. Wipe tests
6. Record-keeping and frequency of required tests

Comprehension

Ex. Identify the proper procedure for performing wipe tests.

Application

Ex. Perform area radiation surveys with appropriate survey instrument and frequency.

Analysis

Ex. Determine if survey or wipe test results exceed regulatory limits and initiate corrective action.

Task #12: Prepare, survey and clean radiotherapy isolation room

Content base

1. NRC regulations
2. Radiation safety procedures
3. Decontamination procedures
4. Area monitoring
    a. Operation of radiation detection devices
    b. Surveys and wipe tests
5. Radioactive waste storage and disposal
6. Record-keeping

Comprehension

Ex. Identify procedure for preventing contamination to contents and surfaces of a room that is to be used by a patient receiving a therapeutic radiopharmaceutical.

Application

Ex. Perform the required surveys and decontamination procedures prior to releasing the room for regular use.

Analysis

Ex. Assess situations and determine procedures to be followed for decontamination and/or storage of room contents used by a radiotherapy patient.

Task #13: Survey, inspect and inventory incoming radioactive materials

Content base

1. Regulatory requirements
    a. NRC
    b. DOT
2. Package monitoring requirements
    a. Survey instruments
    b. Survey methods

    c. Wipe tests
3. Record-keeping

Comprehension

Ex. State limits for radiation levels on packages containing radioactive materials.

Application

Ex. Determine appropriate procedure for receiving package containing radioactive materials.

Analysis

Ex. Determine if package wipe tests and survey results meet regulatory requirements.

Task #14: Monitor and dispose of radioactive material

Content base

1. Regulatory requirements
    a. NRC
    b. DOT
2. Disposal methods for radioactive liquids, solids, gases, and contaminated materials
3. Radiation safety procedures
4. Half-life calculations
5. Survey meters
6. Record-keeping

Comprehension

Ex. Identify disposal procedures for radioactive liquids, solids, gases, and contaminated materials.

Application

Ex. Based on the exposure rate and half-life, estimate the time after which a radioactive material may be disposed.

Analysis

Ex. Determine if materials can be removed from long-term radioactive storage and be disposed of as regular or biohazardous trash.

Task #15: Use proper procedures for managing a radioactive spill

Content base

1. NRC regulations
2. Radioactive spill management
    a. Containment: major & minor spills
    b. Equipment
    c. Trigger levels and monitoring methods
    d. Radiation protection measures
    e. Area decontamination procedures
3. Patient and personnel decontamination
4. Waste disposal

Comprehension

Ex. Distinguish between minor and major spills of radioactive materials.

Application

Ex. Determine the appropriate procedures for containing and decontaminating a radioactive spill and for notifying the proper authority.

Analysis

Ex. Determine when a contaminated area can be returned to regular use.

GROUP II: INSTRUMENTATION (20%)

Task #16: Perform and evaluate quality control on a well counter or probe

Content base:

1. Basic electronics
2. Sodium iodide scintillation detector
    a. System components

    b. Performance characteristics
    c. Quality control
    d. Calibration procedures
3. Gamma ray spectra and pulse height analysis
4. Formulas
    a. Energy resolution
    b. Sensitivity
    c. Chi-square statistic
5. Record-keeping

Comprehension:

Ex. Define background, sensitivity, energy resolution and FWHM as they apply to a sodium iodide detector.

Application:

Ex. Determine proper calibration and FWHM of a well counter or probe.

Analysis:

Ex. Evaluate results of FWHM determination and chi-square test.

Task #17: Calibrate a scintillation camera

Content base:

1. Sodium iodide scintillation camera
    a. Components
    b. Performance characteristics
    c. Calibration procedures
2. Gamma ray spectra and pulse height analysis
3. System sensitivity

Comprehension:

Ex. State the purpose of calibration of a scintillation camera.

Application:

Ex. Determine the appropriate adjustment of the pulse height analyzer of a scintillation camera.

Analysis:

Ex. Evaluate changes in system sensitivity of a scintillation camera and determine causes.

Task #18: Perform and evaluate field uniformity of a scintillation camera

Content base:

1. Scintillation camera
    a. System components
    b. Performance characteristics
    c. Collimators
    d. Image recording equipment
    e. Image quality
2. Uniformity
    a. Procedures
    b. Requirements
    c. Analysis
3. Record-keeping

Comprehension:

Ex. Distinguish between intrinsic and extrinsic field uniformity procedures.

Application:

Ex. Determine the field uniformity of a scintillation camera using images and computer analysis.

Analysis:

Ex. Analyze field uniformity images and differentiate sources of non-uniformity.

Task #19: Perform and evaluate detector linearity and spatial resolution of a scintillation camera

Content base:

1. Scintillation camera
    a. System components

    b. Performance characteristics
    c. Collimators
    d. Image quality
2. Quality control procedures
    a. Linearity
    b. Spatial resolution
    c. Evaluation
3. Phantoms
4. Artifacts
5. Record-keeping

Comprehension:

Ex. Describe a procedure for determining the spatial resolution of a scintillation camera.

Application:

Ex. Determine the linearity and spatial resolution of a scintillation camera.

Analysis:

Ex. Analyze images for non-linearity and/or loss of spatial resolution and determine the causes.

Task #20: Assess performance of image recording equipment

Content base:

1. Scintillation camera
    a. System components
    b. Multiformatter, CRT
2. Computer
    a. Contrast and background controls
    b. Gray and color scales
    c. Matrix sizes
    d. Printers
    e. Video displays
3. Image recording devices
    a. Types
    b. Quality control procedures
4. Photographic film
    a. Characteristics
    b. Film processing
5. Film processor quality control

Comprehension:

Ex. Identify components of the image recording equipment and state their functions.

Application:

Ex. Evaluate performance of image recording equipment.

Analysis:

Ex. Analyze images for proper performance of image recording equipment and assess cause of improper performance.

Task #21: Determine operational status of survey meter

Content base:

1. NRC regulations
2. Survey meter operation
    a. Types
    b. Basic electronics
    c. System components
3. Survey meter quality control
4. Radiation interactions and ranges
5. Record-keeping

Comprehension:

Ex. State required quality control tests for survey meter and their frequency.

Application:

Ex. Evaluate the operational status of a survey meter.

Analysis:

Ex. Assess survey meter operation based on quality control results.

Task #22: Perform and evaluate dose calibrator constancy, accuracy, linearity and geometry tests

Content base:

1. NRC regulations
2. Dose calibrator operation
3. Dose calibrator quality control
    a. Definitions
    b. Procedures
4. Record-keeping

Comprehension:

Ex. Identify timing and record-keeping required for dose calibrator constancy, accuracy, geometry and linearity. Define constancy.

Application:

Ex. Determine the response of a dose calibrator to different source geometries and calculate correction factors. Perform dose calibrator constancy check.

Analysis:

Ex. Analyze accuracy and geometry test results and initiate corrective action as needed. Assess results of constancy check and dose calibrator performance and identify corrective action when necessary.

Task #23: Perform and evaluate quality control procedures for CT imaging system.

Content base:

1. CT Imaging system
    a. System Components
    b. Acquisition parameters
    c. Image Display
    d. Image fusion
    e. Performance characteristics
2. CT Quality control
    a. Light alignment
    b. Slice thickness
    c. HU uniformity
    d. Uniformity
    e. Noise
    f. Contrast resolution
    g. Spatial resolution
    h. Artifacts
3. Record keeping

Comprehension:

Ex. Describe common daily quality control tests for CT scanner.

Application:

Ex. Determine mean pixel value for a region of interest on an image from a CT phantom.

Analysis:

Ex. Analyze quality control test results, and determine the CT scanner's suitability for use

Task #24: Perform and evaluate quality control procedures for a SPECT imaging system

Content base:

1. SPECT camera
    a. System components
    b. Performance characteristics
2. SPECT quality control
    a. Center of rotation
    b. Field uniformity requirements

    c. Pixel calibration
    d. Phantom studies
    e. Artifacts
3. Record-keeping

Comprehension:

Ex. State the requirements for field uniformity for SPECT imaging.

Application:

Ex. Determine pixel size on a scintillation camera.

Analysis:

Ex. Analyze COR test results and assess whether corrections need to be made.

Task #25: Perform and evaluate quality control procedures for a PET imaging system

Content base:

1. PET tomographic system
    a. System components
    b. Application of corrections
    c. Performance characteristics
2. PET quality control
    a. Daily blank scan
    b. Normalization scan
    c. Well counter (absolute activity) calibration
3. Record-keeping
4. Appearance of artifacts

Comprehension:

Ex. Describe the application of normalization correction factors to PET images.

Application:

Ex. Obtain an absolute-activity calibration factor between the PET system and the dose calibrator.

Analysis:

Ex. Analyze daily blank scans for artifacts.

GROUP III: CLINICAL PROCEDURES (45%)

Task #26: Maintain and operate auxiliary equipment (as described in equipment/procedures list)

Content base

1. Theory of operation
2. Use in nuclear medicine procedures
3. Safety requirements
4. Quality control procedures

Comprehension

Ex. Identify and state the proper procedure for use of auxiliary equipment required for imaging procedures.

Application

Ex. Determine appropriate procedures to maintain and operate auxiliary equipment.

Analysis

Ex. Troubleshoot problems with auxiliary equipment.

Task #27: Schedule patient studies, ensuring appropriate sequence of multiple procedures and interact with staff regarding special orders

Content base

1. Imaging and non-imaging procedures
2. Sequence of procedures
3. Radiopharmaceuticals
    a. Effective half-life
    b. Energy ranges
4. Special orders

    a. Premedication
    b. Dietary restrictions
    c. Specimen collection
    d. Radiologic contrast agents
    e. Other
5. Inventory controls
6. Communication skills

Comprehension

Ex. Identify appropriate patient scheduling sequences and special orders for procedures.

Application

Ex. Determine the most appropriate and timely sequence for patient studies and any special orders required.

Analysis

Ex. Analyze patient scheduling difficulties and revise schedule accordingly.

Task #28: Receive patient and provide proper nursing care during medical imaging procedures

Content base

1. Communication skills
2. Basic nursing procedures
    a. Body mechanics
    b. Vital signs
    c. Infection control
    d. First Aid
3. Patient support devices
    a. Intravenous lines/pumps
    b. Oxygen
    c. Foley catheter and drainage bag
    d. ECG monitor
    e. Other
4. Consent for Procedure
    a. Patient Education
5. Pre-examination screening
    a. History
    b. Medications
    c. Adverse reactions to previous studies
    d. Lab Values
6. BUN/Creatinine
7. Coagulation
8. Other

Comprehension

Ex. Identify and state the proper procedure for use of auxiliary equipment required for imaging procedures.

Application

Ex. Determine appropriate nursing care during procedure.

Analysis

Ex. Appraise a situation that requires nursing care be provided and determine the most appropriate action.

Task #29: Communicate effectively with patient, family and staff

Content base

1. Nuclear medicine
    a. Procedures
    b. Patient history
    c. Instructions
    d. Precautions

2. Communication skills
3. Medical ethics
4. Legal aspects of communications

Comprehension

Ex. Identify responsibilities of the technologist in maintaining effective communication with patients, family and staff.

Application

Ex. Recommend appropriate instructions to be given to patients for a particular nuclear medicine procedure.

Analysis

Ex. Determine information that cannot be provided by a nuclear medicine technologist.

Task #30: Provide safe and sanitary conditions

Content base

1. Body mechanics
2. Infection control/Universal Precautions
3. Use of nuclear medicine and auxiliary equipment
4. Waste disposal
    a. Biohazardous
    b. Radioactive
5. Medical/legal aspects

Comprehension

Ex. Identify methods to prevent the spread of infection.

Application

Ex. Determine appropriate methods for handling waste materials.

Analysis

Ex. Analyze a situation to determine if an unsafe condition exists and the appropriate action to be taken.

Task #31: Recognize and respond to emergency conditions

Content base

1. Vital signs
    a. Pulse rate
    b. Respiratory rate
    c. Blood pressure
    d. Temperature
2. Signs/symptoms
    a. Fainting
    b. Seizure
    c. Cardiopulmonary arrest
    d. Hypoglycemia
3. Anaphylactic and vasovagal reactions
4. First aid techniques and cardiopulmonary resuscitation

Comprehension

Ex. Describe symptoms of medical emergencies.

Application

Ex. Determine patient condition and initiate CPR and/or appropriate first aid measures.

Analysis

Ex. Assess an emergency condition and initiate appropriate action.

Task #32: Receive patient, verify patient identification and written orders for study and follow up on inappropriate orders

Content base

1. NRC regulations
2. Patient preparation
3. Medical/legal aspects

4. Communication skills
5. Nuclear medicine procedures
    a. Indications
    b. Contraindications
    c. Patient preparation
    d. Sequence of procedures
6. Record-keeping

Comprehension

Ex. Identify procedures for verifying patient identification and authenticating written orders for study.

Application

Ex. Determine appropriate methods for receiving patients and verifying readiness for study.

Analysis

Ex. Assess appropriateness of orders.

Task #33: Obtain pertinent patient history and check procedural contraindications

Content base

1. Communication skills
2. Medical-legal aspects
3. Organs and organ systems
    a. Anatomy
    b. Physiology
    c. Pathology
    d. Medical and surgical interventions
4. Nuclear medicine procedures
    a. Patient preparation
    b. Patient history
    c. Contraindications
    d. Pre-medications and dietary restrictions
    e. Radiopharmaceutical administration
    f. Other

Comprehension

Ex. Identify contraindications for nuclear medicine procedures.

Application

Ex. Determine if interfering drugs have been stopped for a suitable length of time prior to study.

Analysis

Ex. Analyze consequences of administration of radiopharmaceuticals when contraindications exist.

Task #34: Prepare patient for procedure

Content base

1. Communications skills
2. Procedural requirements
    a. Hydration
    b. Sedation
    c. Route of administration
3. Radiopharmacology
    a. Mechanisms of localization
    b. Biological & effective half-life
    c. Blood clearance rates
    d. Temporal relationship to other medications

Comprehension

Ex. Identify sedatives that can be used for nuclear medicine procedures.

Application

Ex. Determine appropriate patient preparation for specific nuclear medicine procedures.

Analysis

Ex. Assess the consequences of premature or delayed imaging times and initiate corrective measures as appropriate.

Task #35: Select and administer the appropriate radiopharmaceutical by the proper route

Content base

1. Nuclear medicine procedures and approved radiopharmaceuticals and dosages
2. Patient identification
3. Radiopharmaceutical administration
    a. Approved routes
    b. Aseptic technique
    c. Bolus technique
    d. Venipuncture supplies and techniques
    e. Insertion and maintenance of indwelling intravenous line
4. Radiation biology and safety

Comprehension

Ex. Identify the appropriate radiopharmaceuticals for nuclear medicine procedures and their routes of administration.

Application

Ex. Determine best site for intravenous line insertion.

Analysis

Ex. Assess radiation safety consequences of an incorrectly performed radiopharmaceutical administration and take corrective action if necessary.

Task #36: Prepare proper instrument, computer and auxiliary equipment and acquire imaging procedures as indicated by protocol

Content base

1. Nuclear medicine procedures and routine images
2. Patient positioning
    a. Anatomy
    b. Positioning terminology
    c. Anatomical markers
    d. Immobilization techniques
3. Imaging parameters for data acquisition
    a. Collimator choices and zoom settings
    b. Type of acquisition (static, dynamic, gated, SPECT, list mode)
    c. Methods of image termination (time, total counts, information density)
    d. Data storage mode (matrix size, byte vs. word mode)
    e. Number of images in data set
4. Auxiliary equipment operation
5. CT imaging system procedures and routine images
6. Patient positioning
    a. Anatomy
    b. Positioning terminology
    c. Positioning devices
    d. Immobilization techniques
7. Scanning parameters
    a. Scout/survey
    b. Acquisition methods
    c. Scanning parameter selection
    d. Image timing and sequence
    e. Patient specific considerations
8. Dose Modification
    a. Weight based modification for adults
    b. Pediatric
9. Ancillary procedures
    a. Image Fusion

b. Radiation therapy planning
c. Image gating

Comprehension

Ex. Identify routine patient and camera/scanner positions for an imaging procedure.

Application

Ex. Determine the appropriate instrument, imaging and data acquisition parameters and auxiliary equipment necessary to perform an imaging procedure according to protocol.

Analysis

Ex. Assess patient limitations and adapt protocols accordingly.

Task #37: Evaluate image appearance and perform any additional views as required

Content base

1. Nuclear medicine procedures
2. Radiopharmaceuticals
    a. Biodistribution
    b. Causes of altered biodistribution
3. Patient positioning
    a. Anatomy
    b. Positioning terminology
    c. Anatomical markers
4. Quality control procedures

Comprehension

Ex. Identify common artifacts that may appear on images.

Application

Ex. Recommend appropriate special views for an imaging procedure.

Analysis

Ex. Assess diagnostic images and/or computer information for technical quality and initiate corrective measures if appropriate.

Task #38: Process and evaluate computer generated data

Content base

1. Data storage, transfer and retrieval
2. Image formation (static, dynamic, MUGA, list mode)
3. Image reconstruction (SPECT, PET, and CT)
4. Image enhancement
    a. Exponential, logarithmic, and color tables
    b. Filtering
    c. Matrix conversion
5. Quantitative analysis
    a. Regions of interest and quantification
    b. Curve generation and analysis
    c. Image normalization and subtraction
    d. Co-registration of image sets
6. Display formatting (size of image, number of images per film, intensity enhancement)
7. Quality control procedures

Comprehension

Ex. Identify techniques to retrieve and process computer data.

Application

Ex. Determine the appropriate technique for quantitative analysis of a nuclear medicine study.

Analysis

Ex. Analyze computer-generated information for technical quality and artifacts and initiate corrective measures if appropriate.

Task #39: Prepare and perform cardiac monitoring and/or stress testing

Content base

1. Nuclear cardiology procedures
2. Basic electrocardiography
    a. Cardiac conduction system
    b. The normal electrocardiogram
    c. Basic ECG interpretation
    d. Arrhythmias
3. ECG lead placement
    a. 3 lead
    b. 12 lead
4. Treadmill/bicycle stress techniques
    a. Contraindications
    b. Duration/termination parameters
5. Pharmacological stress techniques
    a. Pharmacologic stress agents
    b. Contraindications
    c. Duration/termination parameters
    d. Drug side-effects and appropriate treatment
    e. Reversal agents and techniques
6. Vital signs
    a. Pulse rate
    b. Respiratory rate
    c. Blood pressure
7. Signs/symptoms of adverse reactions
8. CPR techniques
9. Record-keeping

Comprehension

Ex. Identify components of a normal electrocardiogram and common arrhythmias.

Application

Ex. Determine the appropriate duration and termination parameters for a stress test.

Analysis

Ex. Assess a patient's history for contraindications to stress testing.

Task #40: Obtain samples and/or data for non-imaging studies

Content base

1. Nuclear medicine procedures
2. Collection techniques for patient specimens
    a. Timing
    b. Methods and containers
    c. Storage
3. Hematocrit determination
4. Standard dilution preparation
5. Specimen preparation
6. Counting statistics and background correction
7. External counting techniques

Comprehension

Ex. Identify type of specimen required for given procedure and describe collection, preparation, and storage procedures.

Application

Ex. Determine the appropriate dilution of a standard for a given procedure and calculate the amount of sample and solvent required.

Analysis

Ex. Evaluate specimen quality and obtain new specimen if necessary.

Task #41: Calculate and evaluate results of non-imaging studies

Content base

1. Nuclear medicine procedures

2. Error analysis
    a. Sources of random error
    b. Sources of systematic error
    c. Precision
    d. Accuracy
    e. Procedure-specific sources of error
3. Calculations
    a. Equations
    b. Graphing techniques
    c. Data presentation
    d. Derivation of appropriate patient values
4. Patient records and reports
    a. Contents
    b. Medical-legal considerations
5. Instrument quality control procedures

Comprehension

Ex. Identify formula and/or graphing technique required to calculate results of a non-imaging procedure.

Application

Ex. Determine final results of a given nonimaging procedure using the appropriate formulae and/or graphing technique.

Analysis

Ex. Analyze data to differentiate acceptable from unacceptable data and determine source of error.

GROUP IV: RADIOPHARMACY (20%)

Task #42: Prepare/administer interventional pharmacologic agent

Content base

1. Nuclear medicine procedures
2. Approved interventional pharmacologic agents
    a. Contraindications and precautions
    b. Normal physiologic response
    c. Adverse side-effects and treatment
    d. Antidote medications
3. Pharmaceutical administration
    a. Dosages
    b. Approved routes
    c. Aseptic technique
    d. Administration and timing/speed/duration
    e. Reversal agents and techniques
4. Administration of oral/IV contrast media
    a. Types and characteristics of contrast media
    b. Indications and contraindications for usage
    c. Storage and preparation for use
    d. Dosage, routes of administration, and timing
5. Vital signs
    a. Pulse rate
    b. Respiratory rate
    c. Blood pressure
6. Adverse reactions
7. Emergency techniques
8. Record-keeping

Comprehension

Ex. Identify dosage, time, speed and duration of dose administration for nuclear medicine procedures requiring pharmacologic intervention.

Application

Ex. Determine whether the patient's history identifies possible contraindications for the use of particular interventional agents.

Analysis

Ex. Assess whether a patient is having an adverse reaction to a particular interventional agent and determine appropriate action to be taken.

Task #43: Elute radionuclide generator, perform and evaluate quality control tests

Content base:

1. Types of generators
    a. Elution
    b. Generator yield - volume and activity
2. Aseptic techniques
3. Regulatory requirements
    a. NRC
    b. USP
4. Dose calibrator operation/ units of radioactivity
5. Mo-99 and Al+3 breakthrough testing
6. Record-keeping

Comprehension:

Ex. Identify methods used to assay generator eluate and information that must appear on the label.

Application:

Ex. Elute generator using proper shielding and aseptic techniques.

Analysis

Ex. Assess radionuclidic and chemical purity of eluate and determine methods to minimize contamination.

Task #44 Review the daily work schedule to plan radiopharmaceutical needs

Content base

1. Patient scheduling
2. Nuclear medicine procedures
    a. Appropriate radiopharmaceuticals and activity ranges
    b. Time interval between radiopharmaceutical administration and procedure
3. Radiopharmaceuticals
    a. Activity and volume limits
    b. Effect of radioactive decay
    c. Shelf life
4. Record-keeping

Comprehension

Ex. Identify the radiopharmaceutical and activity required for each procedure.

Application

Ex. Determine radiopharmaceutical needs required to complete daily work schedule based on shelf-life and decay.

Analysis

Ex. Adjust daily work schedule and/or radiopharmaceutical kit preparation to use available radiopharmaceutical inventory effectively.

Task #45 Prepare radiopharmaceutical kits, perform quality control and evaluate results

Content base:

1. Radiopharmaceutical kits
    a. Preparation techniques
    b. Activity and volume limitations
    c. Activity calculations
2. Radiopharmaceutical quality control
    a. Visual inspection - color and clarity

    b. Microscopic inspection - particle size
    c. Radiochemical purity
3. Dose calibrator operation and units of activity
4. Regulatory requirements
    a. NRC
    b. USP
5. Label contents
    a. Radiopharmaceutical name
    b. Concentration
    c. Expiration date/time
    d. Total activity
    e. Assay time and date
6. Storage of kits before and after reconstitution
7. Record-keeping

Comprehension:

Ex. Define radiochemical purity and state acceptable limits of impurities.

Application

Ex. Determine total volume and radioactivity to be added to a radiopharmaceutical kit within stated limits.

Analysis:

Ex. Analyze circumstances leading to improper particle size, color or clarity of a radiopharmaceutical and assess whether patients and/or nuclear medicine procedures would be adversely affected.

Task #46 Prepare and dispense diagnostic radiopharmaceuticals

Content base:

1. Regulations
    a. NRC
    b. USP
    c. FDA
2. Units of activity and decay calculations
3. Vial/syringe label contents
    a. Date and time of preparation
    b. Radiopharmaceutical identity and lot number
    c. Total volume and activity
    d. Specific activity and/or concentration
4. Nuclear medicine procedures and acceptable radioactivity ranges
5. Dose calculations, including pediatric doses and unit dose adjustments
6. Aseptic technique
7. Dose calibrator operation
8. Administration of radiopharmaceutical dose
9. Operation of radioactive gas/ aerosol administration equipment
10. Record-keeping

Comprehension:

Ex. Identify required written records for radiopharmaceutical preparation and administration and the length of time these record must be kept.

Applications:

Ex. Calculate activity, volume or number of capsules to be administered for a specific procedure.

Analysis:

Ex. Determine adjustments to a unit dose volume to allow use of the dose prior to the calibration time.

Task #47: Prepare and dispense therapeutic radiopharmaceuticals

Content base:

1. Regulations
    a. NRC

    b. USP
    c. Total quality management/written directive
2. Units of activity and decay calculations
3. Vial/dose container label contents
    a. Date and time of administration
    b. Radiopharmaceutical identity and lot number
    c. Total activity
    d. Total volume
    e. Specific activity/concentration
4. Aseptic technique
5. Radiation safety precautions
6. Dose calibrator operation
7. Administration of therapeutic radiopharmaceuticals
8. Record-keeping

Comprehension

Ex. State the regulations on misadministration of a therapeutic radiopharmaceutical.

Applications:

Ex. Determine the procedure to withdraw an accurate volume of radiopharmaceutical into a syringe using aseptic technique and radiation safety precautions.

Analysis:

Ex. Analyze circumstances leading to a misadministration and recommend corrective action.

Task #48: Label blood components with a radiopharmaceutical according to protocol for procedure

Content base:

1. Labeling procedure
    a. Required lab equipment and supplies
    b. Anticoagulants and other additives
    c. Chemical reactions
    d. Cell washing
    e. Radiopharmaceuticals required
2. Aseptic technique
3. Centrifuge operation
4. Calculation of labeling efficiency and administered dosage
5. Determination of cell viability
6. Record-keeping

Comprehension:

Ex. Identify appropriate blood components, equipment and supplies necessary to label cells with a radiopharmaceutical.

Application:

Ex. Determine appropriate procedure for labeling blood cells with a given radiopharmaceutical.

Analysis

Ex. Analyze adequacy of cell labeling using viability studies or image quality.

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